ENERGY REPORT

ENERGY ENGINEERING ANALYSIS PROGRAM

LIMITED ENERGY STUDY OF STEAM DISTRIBUTION SYSTEMS

HAWTHORNE ARMY AMMUNITION DEPOT HAWTHORNE, NEVADA

JUL 1995

PREPARED FOR

DEPARTMENT OF THE ARMY
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SACRAMENTO, CALIFORNIA

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1.0 Executive Summary

1.1 Introduction

This report summarizes all work of the Limited Energy Study of Steam Distribution Systems, Energy Engineering Analysis Program, Hawthorne Army Ammunition Depot (HWAAD), Nevada. The project is authorized under Contract No. DACA05-92-C-0155 with the U.S. Army Corps of Engineers, Sacramento District, California.

The purpose of this limited energy study is to evaluate steam distribution and condensate collection systems in both the Industrial Area and Ordnance Area of HWAAD to develop a set of replacement actions that will reduce energy consumption and operating costs.

These efforts consist of corrections and revisions to previously submitted funding requests. Amended DD Forms 1391 and supporting documentation are prepared for:

- Project 40667, Modernize Steam Distribution System, Industrial Area, and
- Project 42166, Modernize Ordnance Area Steam Distribution, Ordnance Area.

1.2 Descriptions of Existing Facilities

HWAAD is located next to Highway 95 near the center of Nevada's border with California, about 130 miles southeast of Reno. The elevation is about 4,100 feet. The location is depicted on Figure 1-1. A number of facilities covering over 140,000 acres constitute HWAAD; however, this study was limited to the Industrial and Ordnance Areas. Distribution systems are shown on Figures 1-2 and 1-3.

1.2.1 Industrial Area

The Industrial Area is located west of Highway 95 and consists of administrative offices and maintenance shops. Family housing, dormitories for soldiers and a golf course are also located there.

The steam plant located in building 13 serves the area. Three steam boilers are operated when space heating is required. The boiler operating and steam distribution pressure is about 100 pounds per square inch (psig). Reduced pressure distribution is provided for the family housing area. Condensate is returned to the boiler plant through a system of pumped and gravity return lines.

The steam distribution and condensate return system is installed either in concrete trenches (covers form sidewalks) or is direct buried. Extensive repairs have been performed over the years and some piping has been replaced. The system is presently deteriorated.

Uninsulated fiber reinforced plastic pipe (FRP), or fiberglass pipe, was installed in much of the family housing area to replace condensate return piping. The FRP pipe has sustained extensive damage from exposure to temperatures above 250°F.

1.2.3 Ordnance Area

The Ordnance Area 103 is located a few miles east of Highway 95, across the highway from the Industrial Area. Explosives are processed in the 103 Area, thus, buildings are located distant from one another. Only a few of the existing facilities are in current use.

Building 103-6 houses the central steam plant serving all buildings in the 103 Area. Steam is generated in three boilers and is distributed to buildings at about 112 psig. Condensate is returned via a pumped system. Both steam distribution and condensate return piping are encased within a single conduit. Frequent repairs have been required.

1.3 Selection of Replacement Piping Systems

Several alternative piping system types were evaluated. The evaluations were performed separately for each type of placement for the predominant pipe size in each area. Note that the costs listed below were for selecting the piping system only. Actual replacement costs were determined separately.

1.3.1 Industrial Area Replacement Piping System Selection

Existing Industrial Area piping is installed either in shallow concrete trenches or is direct buried. The predominant pipe sizes used for evaluations include 4-inch steam and 3-inch condensate pipe diameters.

Industrial Area concrete trench replacement piping systems evaluated and their total costs considering both construction and maintenance costs are:

- Preengineered steel steam and condensate pipes in a common conduit laid on a sand bed in the existing trench (Alternative CT1): $204.20 per foot
- Preengineered steel steam and FRP condensate pipes in separate conduits laid on a sand bed in the existing trench (Alternative CT2): $299.23 per foot
- Preengineered steel steam and condensate pipes in separate conduits laid on a sand bed in the existing trench (Alternative CT3): $184.53 per foot
- Separate field fabricated steel steam and condensate pipes placed on existing rollers in the existing concrete trench (Alternative CT4): $93.92 per foot

Industrial Area direct burial replacement piping systems evaluated include:

- Preengineered steel steam and condensate pipes in a common conduit (Alternative DB1): $209.90 per foot
- Preengineered steel steam and FRP condensate pipes in separate conduits (Alternative DB2): $307.20 per foot
- Preengineered steel steam and condensate pipes in separate conduits (Alternative DB3): $188.80 per foot

The alternatives with the lowest total costs are Alternative DB3 for direct burial pipe sections and Alternative CT4 for sections of piping replacements within existing concrete trenches.

1.3.2 Ordnance Area Replacement Piping System Selection

Above ground and underground alternatives are considered for the Ordnance Area. Above ground is less costly than underground piping, thus, replacement will be predominantly above ground. Underground piping will be used for street and railroad crossings. The predominant pipe sizes used in evaluations are 8-inch for steam and 4-inch for condensate return pipes.

Above ground piping systems considered for the Ordnance Area and the total costs, including both construction and maintenance costs, are:

- Preengineered steel steam and condensate pipes in a common conduit on pipe supports (Alternative A1): $723.16 per foot
- Preengineered steel steam and FRP condensate pipes in separate conduits on pipe supports (Alternative A2): $629.82 per foot
- Preengineered steel steam and condensate pipes in separate conduits on pipe supports (Alternative A3): $560.38 per foot
- Field fabricated steel steam and condensate pipes on pipe supports (Alternative A4): $213.22 per foot

Ordnance Area direct burial replacement piping systems evaluated include:

- Preengineered steel steam and condensate pipes in a common conduit (Alternative U1): $686.30 per foot
- Preengineered steel steam and FRP condensate pipes in separate conduits (Alternative U2): $641.43 per foot

- Preengineered steel steam and condensate pipes in separate conduits (Alternative U3): $570.34 per foot

The aboveground and underground alternatives with the least total costs are A4 and U3. The above ground alternative A4 total cost is considerably below that of the underground selection, thus, above ground replacements are maximized. Underground replacement piping is used only where necessary, i.e., only for street and railroad crossings.

1.4 Evaluation of Distribution Piping Replacements

1.4.1 Piping Replacement Alternatives

Replacement of all the piping in both the Industrial and Ordnance Areas is considered. Unfortunately, available funds cannot accommodate complete system replacements. Each areas distribution system is divided into segments for consideration. Several segments are selected for replacement in each of the two areas. The selections of segments recommended for replacement are prioritized based on the greatest need for replacement within reach of the available funds. Piping segments recommended for replacement are shown on Figures 1-4 and 1-5; cost estimates are summarized on Tables 1-1 and 1-2.

1.4.2 Energy Savings

Energy and maintenance cost savings are achieved by replacing piping. Energy savings are from reduced heat losses to the air and ground and the from reduced leakage. Energy loss calculations for leaks are based on makeup water and fuel consumption records and from boiler combustion efficiency measurements.

Thermal losses to the air and ground from conduction and convection losses are calculated based on thermodynamic properties of the piping systems and on steam and condensate system operating temperatures. Refer to Appendix C for detailed calculations.

The energy savings from each source for sections of the distribution systems recommended for repair are:

Type of Savings	Industrial Area	Ordnance Area
Steam and Condensate Leaks (Million BTU / year)	16,290	7,396
Thermal Losses from Piping (Million BTU / year)	8,646	9,875
Total No. 2 Fuel Oil Savings (Million BTU / year)	24,936	17,271

1.4.3 Maintenance Labor Savings

Labor savings are achieved by reducing the amount of effort required to keep deteriorated piping systems operational. Based on the latest year for which complete maintenance records are available,

labor savings are estimated at 3,225 hours per year in the Industrial Area and 2,775 labor hours per year in the Ordnance Area.

1.4.4 Life Cycle Cost Analyses

Life cycle cost analyses were conducted for both recommended repair projects. The analyses are provided on Tables 1-3 and 1-4 for the Industrial and Ordnance Areas, respectively. Results are:

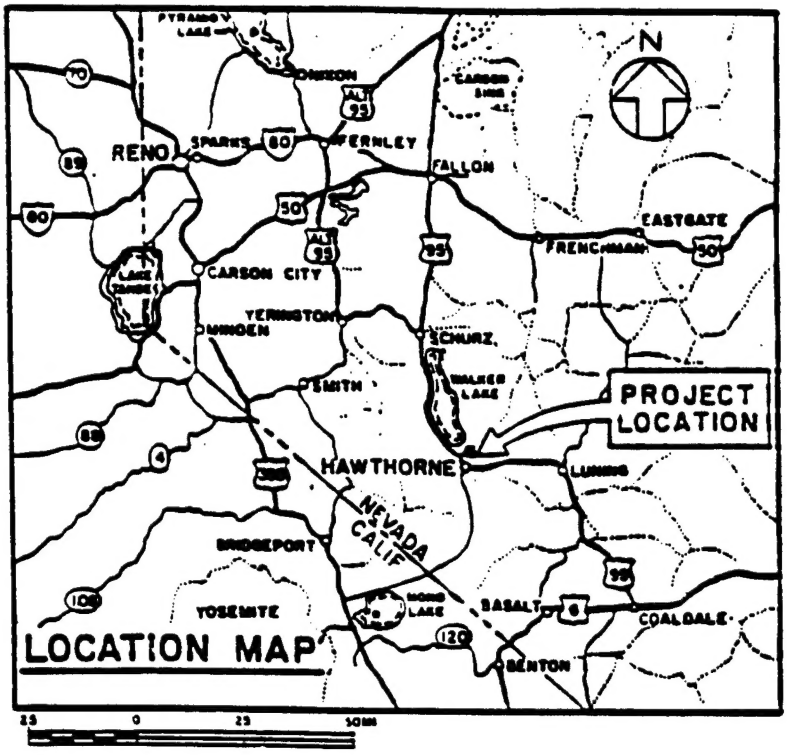
- Industrial Area

Investment (including SIOH and Design):	$851,618	
Savings to Investment Ratio:	3.87	
Simple Payback Period:	3.43	years

- Ordnance Area

Investment (including SIOH and Design):	$1,198,535	
Savings to Investment Ratio:	2.39	
Simple Payback Period:	5.43	years

Figure 1-1
Site Location Map



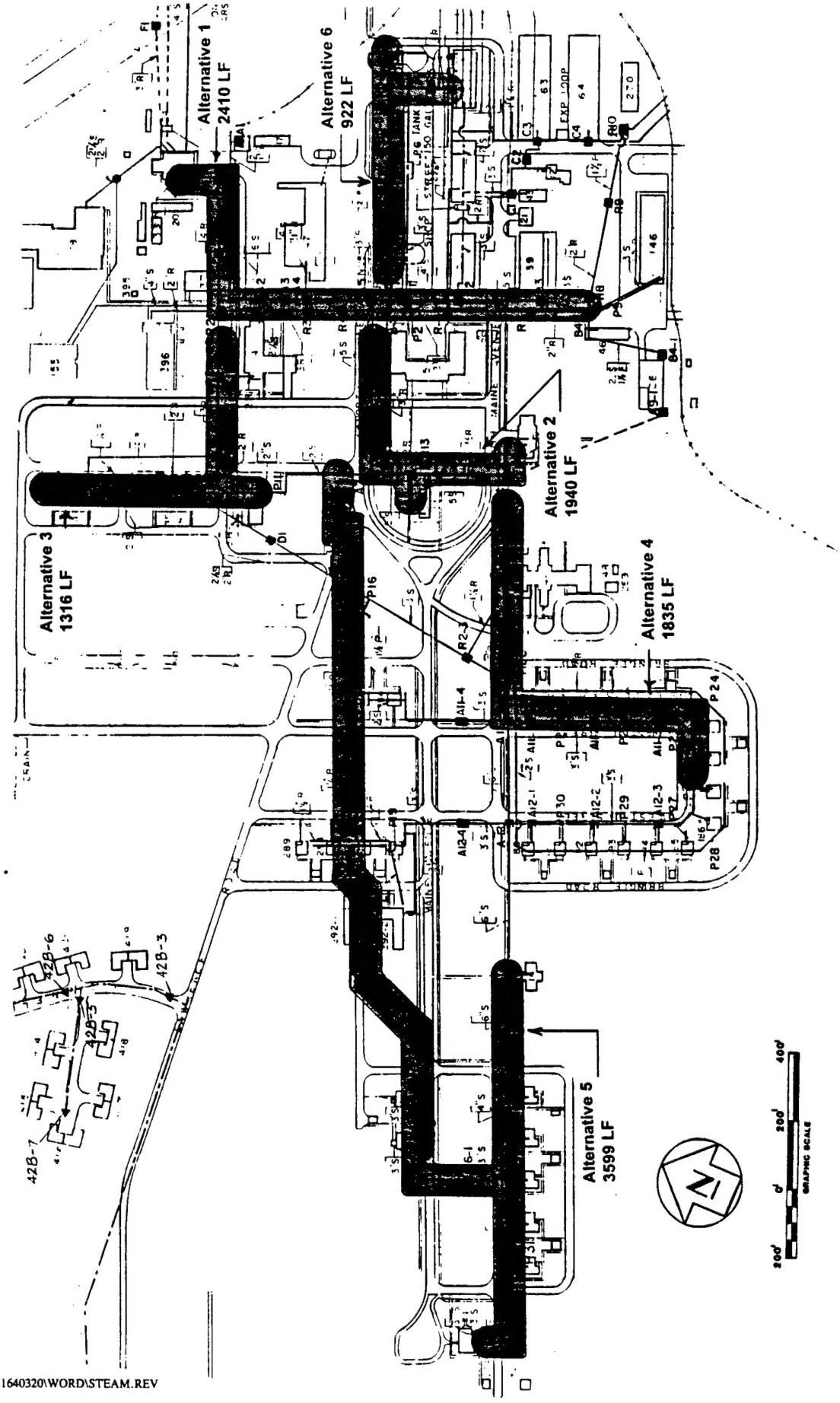


Figure 1-2
Industrial Area Steam Distribution System Pipe Replacement Alternatives

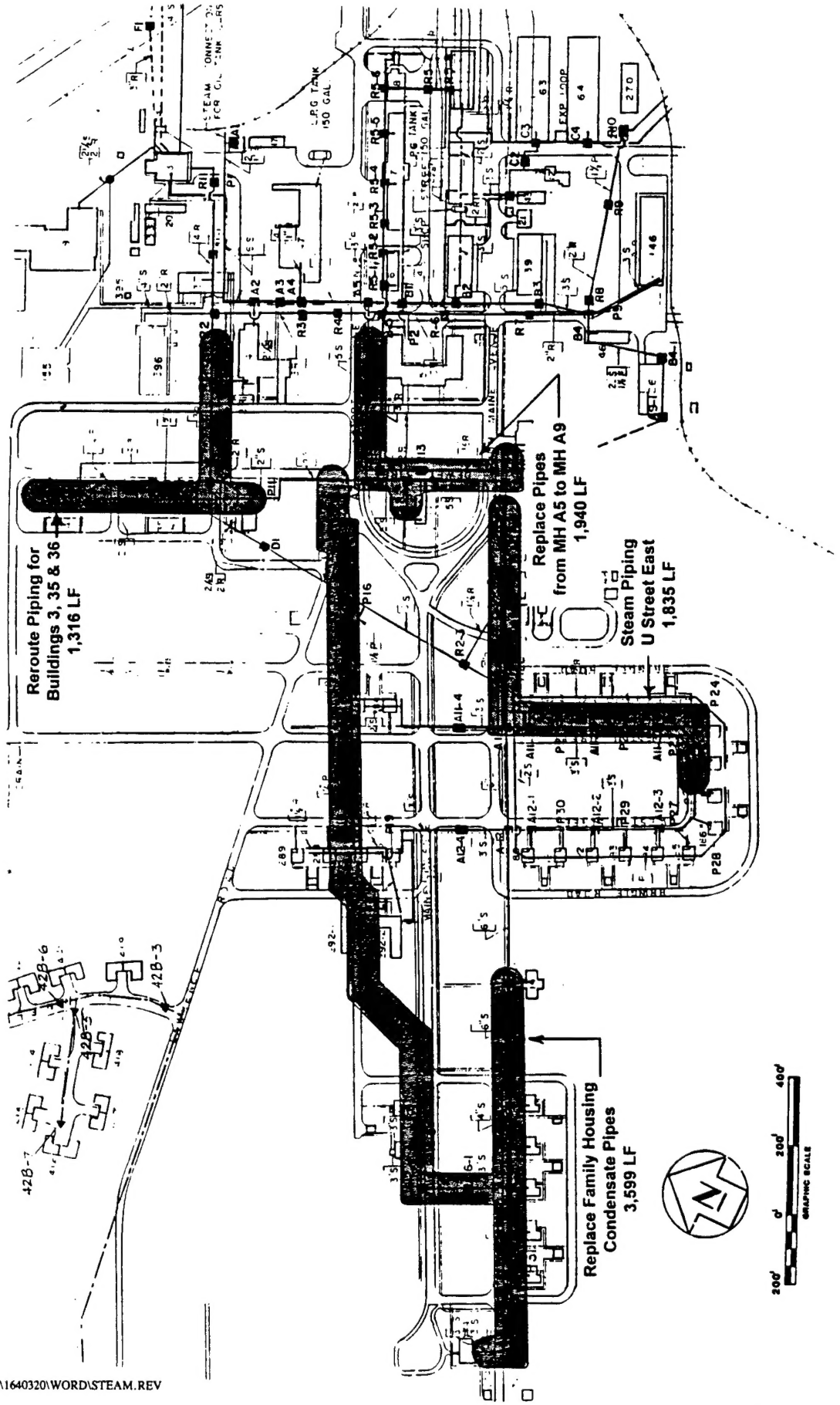


Figure 1-3
Industrial Area Steam Distribution System Recommended Pipe Replacement Alternatives

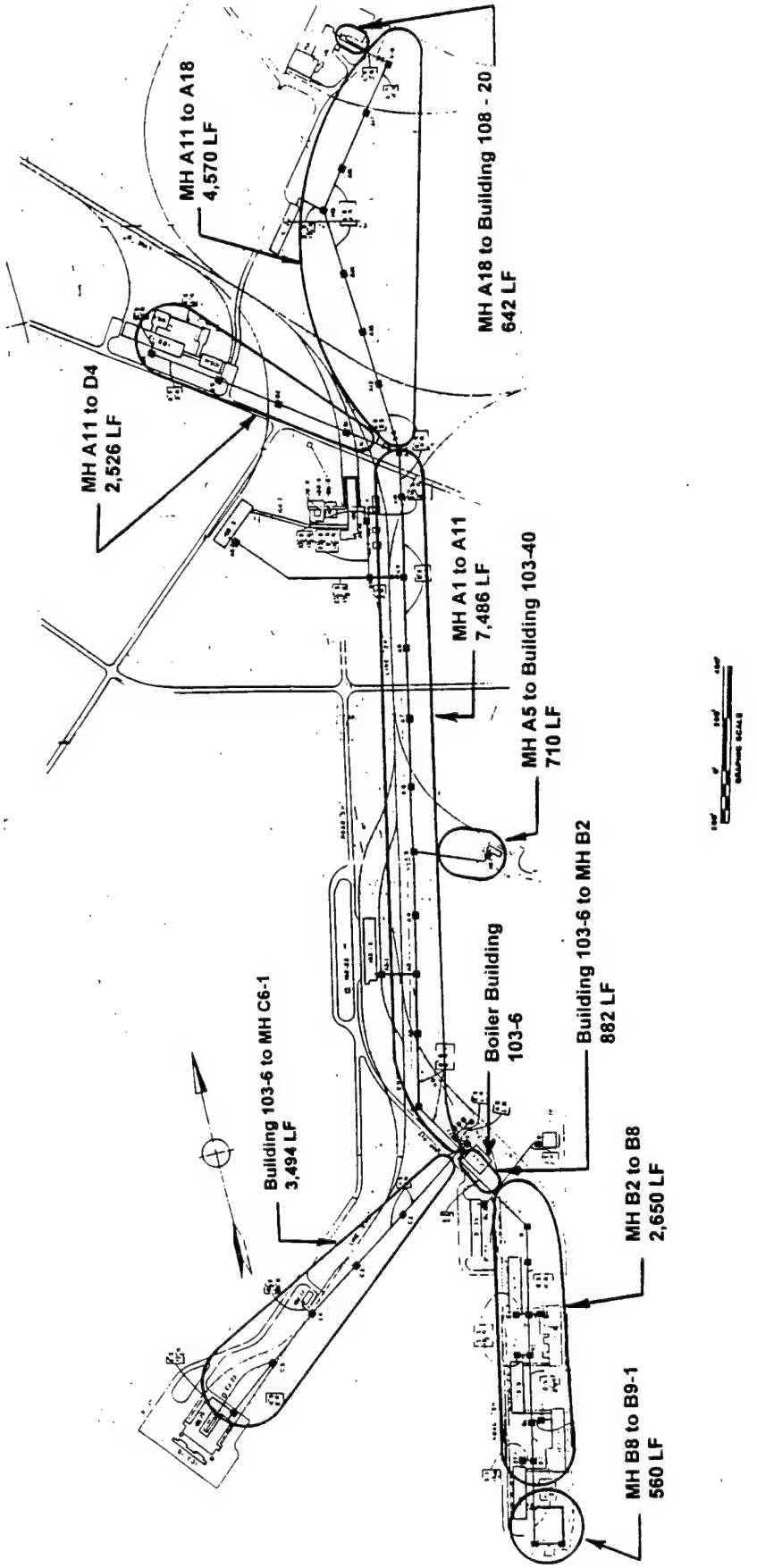


Figure 1-4
OrdnanceArea Steam Distribution System Pipe Replacement Alternatives

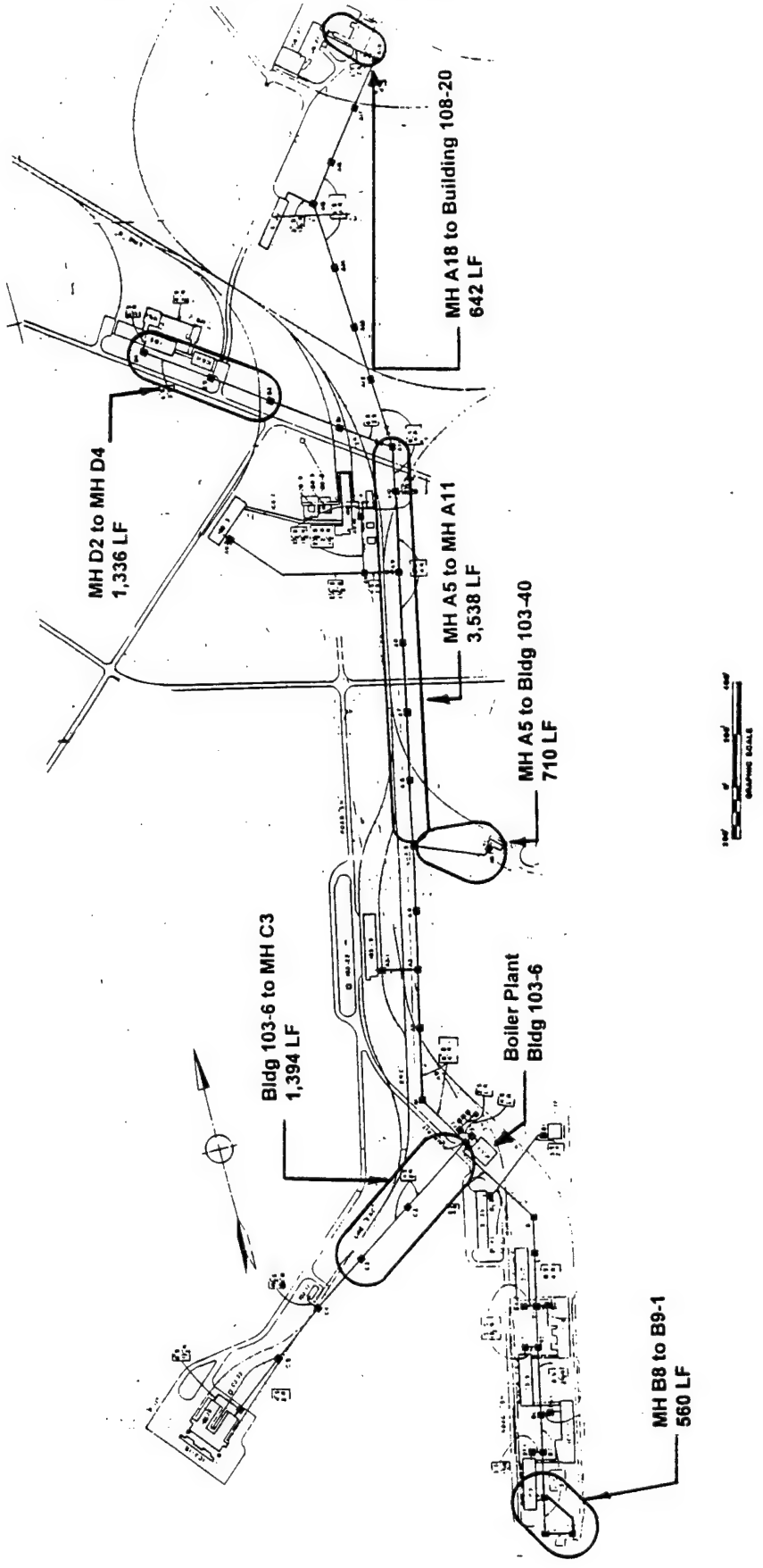


Figure 1-5
Ordnance Area Steam Distribution System Recommended Pipe Replacement Alternatives

Table 1-1
Summary of Piping Replacement Costs
Industrial Area Steam and Condensate System

Alt.	Alternative Description	Base Case, Total Lengths Total LF	Cost $	$/LF	Recommended Total LF	Cost $
1	Replace Pipes Bldg 13 to MH B4	2,410	$266,492	$110.58	-	-
2	Replace Pipes MH A5 to MH A9	1,940	$165,343	$85.23	1,940	$165,343
3	Rerouting for Buildings 3, 35 & 36	1,316	$157,696	$119.83	1,316	$157,696
4	Steam Piping - U Street East	1,835	$158,033	$86.12	1,835	$158,033
5	Family Housing Condensate Pipes	3,599	$282,027	$78.36	3,599	$282,027
6	Shop Area Condensate Piping	922	$106,940	$115.99	-	-
Total of Industrial Area Alternatives		**12,022**	**$1,136,531**	**$94.54**	**8,690**	**$763,099**
SIOH 5.6%			$63,646			$42,734
Design 6.0%			$68,192			$45,786
Total Request		**12,022**	**$1,268,368**	**$105.50**	**8,690**	**$851,618**

Table 1-2
Summary of Above Ground Piping Replacement Costs
Ordnance Area Steam and Condensate System
(Road and Rail Crossings Underground)

		Base Case, Total Lengths			Recommended	
Alt.	Pipe Run Description	Total LF	Cost $	$/LF	Total LF	Cost $
1	MH A1 to MH A11	7,486	$1,020,250	$136.29	-	-
	MH A5 to MH A11	-	-	-	3,538	$531,951
2	MH A11 to MH A18	4,570	$603,930	$132.15	-	-
3	MH A11 to MH D4	2,526	$360,732	$142.81	-	-
	MH D2 to MH D4	-	-	-	1,336	$191,263
4	MH A18 to Bldg 108-20	642	$90,837	$141.49	642	$90,837
5	MH A5 - Bldg 103-40	710	$42,631	$60.04	710	$42,631
6	Bldg 103-6 to MH C6-1	3,494	$328,594	$94.05	-	-
	Bldg 103-6 to MH C3	-	-	-	1,394	$167,348
7	Bldg 103-6 to MH B2	882	$136,571	$154.84	-	-
8	MH B8 to MH B9-1	560	$49,925	$89.15	560	$49,925
9	MH B2 to MH B8	2,650	$411,344	$155.22	-	-
Total Ordnance Area Piping		**23,520**	**$3,044,814**	**$129.46**	**8,180**	**$1,073,956**
SIOH 5.6%			$170,510			$60,142
Design 6.0%			$182,689			$64,437
Total Request		**23,520**	**$3,398,013**	**$144.47**	**8,180**	**$1,198,535**

Table 1-3
Life Cycle Cost Analysis Summary - Industrial Area

Location: Hawthorne Army Ammunition Depot Region No. 4 Project No. 40667
Project Title: ECIP Modernize Industrial Area Steam Distribution Fiscal Year FY97
Discrete Portion: Total Project Preparer: KELLER & GANNON
Analysis Date: July 1995 Economic Life: 15 Years

1. Investment Costs				
A. Construction Costs		$763,099		
B. SIOH	5.6%	$42,734		
C. Design Cost	6.0%	$45,786		
D. Total Cost (1A + 1B + 1C)		$851,618		
E. Salvage Value of Existing Equipment			$0	
F. Public Utility Company Rebate			$0	
G. Total Investment (1D-1E-1F)				$851,618

2. Energy Savings (+)/Cost(-):

Date of NISTIR 85-3273 Used for Discount Factors: October 1994

Energy Source	Cost $/MBTU	Saving MBTU/Yr(2)	Annual $ Savings(3)	Discount Factor(4)	Discounted Savings(5)
A. Elec.	$12.82	0	$0	12.02	$0
B. Dist	$6.13	23,723	$145,423	14.23	$2,069,366
C. LPG					
D. Other					
E. Demand Savings		0.0 kW	$0	11.30	$0
F. Total		23,723	$145,423		$2,069,366

3. Non Energy Savings (+) or Cost (-):

A. Annual Recurring (+/-)	$102,620		
(1) Discount Factor (Table A)		11.94	
(2) Discounted Savings/Cost (3A x 3A1)			$1,225,277

B. Non Recurring Savings (+) or Cost (-)

Item	Savings(+) Cost(-)(1)	Year of Occur. (2)	Discount Factor(3)	Discounted Savings(+)Cost(-)(4)
a.				
b.				
c.				
d. Total				

C Total Non Energy Discounted Savings (3A2 + 3Bd4)	$1,225,277	
4. First Year DollarSavings (2F3 + 3A + (3Bd1/Economic Life)):	$248,042	
5. Simple Payback (1G/4):	3.43	Years
6. Total Net Discounted Savings (2F5 + 3C):	$3,294,643	
7. Savings to Investment Ratio (SIR) (6/1G):	3.87	

Table 1-4
Life Cycle Cost Analysis Summary - Ordnance Area

Location: Hawthorne Army Ammunition Depot Region No. 4 Project No. 42166
Project Title: ECIP Modernize Ordnance Area Steam Distribution Fiscal Year FY97
Discrete Portion: Total Project Preparer: KELLER & GANNON
Analysis Date: July 1995 Economic Life: 15 Years

1. Investment Costs			
A. Construction Costs	$1,073,956		
B. SIOH 5.6%	$60,142		
C. Design Cost 6.0%	$64,437		
D. Total Cost (1A+1B+1C)	$1,198,535		
E. Salvage Value of Existing Equipment		$0	
F. Public Utility Company Rebate		$0	
G. Total Investment (1D-1E-1F)			$1,198,535

2. Energy Savings (+)/Cost(-):

Date of NISTIR 85-3273 Used for Discount Factors: October 1994

Energy Source	Cost $/MBTU	Saving MBTU/Yr(2)		Annual $ Savings(3)	Discount Factor(4)	Discounted Savings(5)
A. Elec.	$12.82	0		$0	12.02	$0
B. Dist	$6.13	16,549		$101,447	14.23	$1,443,592
C. LPG						
D. Other						
E. Demand Savings		0.0	kW	$0	11.30	$0
F. Total		16,549		$101,447		$1,443,592

3. Non Energy Savings (+) or Cost (-):			
A. Annual Recurring (+/-)	$119,261		
(1) Discount Factor (Table A)		11.94	
(2) Discounted Savings/Cost (3A x 3A1)			$1,423,970

B. Non Recurring Savings (+) or Cost (-)

Item	Savings(+) Cost(-)(1)	Year of Occur. (2)	Discount Factor(3)	Discounted Savings(+)Cost(-)(4)
a.				
b.				
c.				
d. Total				

C Total Non Energy Discounted Savings (3A2+3Bd4)	$1,423,970	
4. First Year DollarSavings (2F3+3A+(3Bd1/Economic Life)):	$220,708	
5. Simple Payback (1G/4):	5.43	Years
6. Total Net Discounted Savings (2F5+3C):	$2,867,562	
7. Savings to Investment Ratio (SIR) (6/1G):	2.39	